3 Monitoring and Control

3.1 Monitoring technologies

Monitoring System

- Monitoring or measuring involves the use of a computer or microprocessor based device to monitor or measure physical variable over a period of time.
- Monitoring systems process and record data so that people can see trends in the changes that are taking place in the environment being monitored
- It makes use of sensors which converts physical variables like temperature, light or pressure and converts into a signal which can be measured electrically
- These sensors continually send data back to the computer or microprocessor.
- Most of the sensors used in monitoring system are analogue hence the data sent to computer is in analogue form.
- This data is converted into digital form using an Analogue to Digital Convertor (AADC) which can be processed by the computer
- The output from the system is usually on a screen or printed out but can be a warning sound if the monitoring that is taking place is critical for example a nuclear reactor
- The monitoring process is continuous and never ends

Sensors

Type of sensor	Description and use
Light/ultraviolet	Light sensors, as the name suggests, measure the amount of light. There are many types of light sensor, but they all follow the same principle. When light falls on this type of sensor, it generates electrical energy. The amount of energy is then converted to give a value for the amount of light. These sensors can be used in weather stations to measure the amount of sunshine. Ultraviolet sensors are used to measure the amount of UV (specifically UVB radiation, which can be dangerous to humans, sometimes causing skin cancer).
Temperature	The components of different types of temperature sensor either change their electrical resistance or generate a voltage according to temperature. Whichever type is used, electrical signals are generated which are converted into values to represent temperature. These sensors are used to feed data back to the computer about, for example, the **ambient temperature** in a weather station, the temperature in a river or air quality.
Pressure	A pressure sensor converts the force applied to its surface to generate electrical energy which is then converted into values to represent the applied pressure. These sensors are used to measure atmospheric pressure in weather stations.
Humidity/moisture	Humidity sensors are often a combination of a moisture sensor and a temperature sensor in one unit. This is because humidity can only be calculated by knowing how much water there is in the atmosphere together with the temperature. A moisture sensor is actually a combination of a light sensor and a light emitter, as the amount of light transmitted depends on the moisture content of the air. Humidity sensors are used to measure the air humidity in a weather station. Moisture sensors are also used when monitoring soil quality.
Sound	These sensors convert sound waves into voltages or electrical signals which are converted by the computer into values to represent sound. Sound sensors can be used in environmental monitoring systems to measure noise pollution.
Infrared	All bodies possess thermal energy and therefore emit infrared radiation. This radiation is converted into electrical signals as a result. These sensors can be used in environmental monitoring, for example the Earth's surface temperature can be monitored by satellites.
Oxygen, carbon dioxide, pH, turbidity	These are sensors used in environmental monitoring and water pollution monitoring. Oxygen (O_2) sensors measure the level of oxygen in soil and water. Carbon dioxide (CO_2) sensors measure the level of carbon dioxide in the air or in water and are basically an adaptation of an infrared sensor. pH sensors measure the acidity of soil and acidity in rivers, lakes, etc. They are very similar to a simple battery and generate electricity depending on the number of hydrogen ions in the solution, which causes an electrode to generate a voltage. Turbidity sensors measure the cloudiness of water in a river that is affected by pollution. A turbidity sensor is actually a light sensor usually placed at right angles to a light emitter. The greater the number of particles in the water, the greater the amount of light reflected off them on to the sensor.
Reed switch	Strictly speaking, a reed switch is not a sensor, but it is used to help measure rainfall (see the next section about the uses of monitoring technologies in weather stations).

▲ Table 3.1 Uses of common sensors

Uses of Monitoring Technologies

Weather Stations

Weather stations could be sued to measure the weather in terms of temperature, rainfall, hours of sunlight, atmospheric pressure, humidity and UV radiation. For this purpose it would need:

- **temperature sensors:** To measure the ambient temperature. When referring to weather, ambient temperature means the temperature of the surrounding air of the weather station
- **pressure sensors:** To measure the atmospheric pressure, which is the pressure of the air above us. Pressure readings are sued to formulate weather forecasts, high pressure is an indication of sunny weather and low pressure is an indication of wet and windy weather
- **humidity sensors:** To measure absolute and relative humidity. Absolute humidity is the amount of moisture in the air, measured without taking temperature into account; it is measured using water per cubic meter of air. Relative humidity considers the temperature of the air and is a percentage value, it is the fraction of the amount of moisture in the air compared to the maximum amount of water that could be held in air at that temperature. It is used to predict the likelihood of rain and snow occurring
- **light sensors:** To measure the number of hours of sunlight. Measuring sunlight requires an array of light sensors which collectively measure the intensity of the light radiation
- **a tipping bucket and a reed switch:** To measure rainfall. It makes use of a bucket which tips after reaching a certain weight due to rain, and empties the water. It then tips back to collect further rainfall. The tipping of the bucket activates a reed switch which sends a signal back to the microprocessor. The microprocessor, counting the number of times the bucket tips, performs a calculation to work out the amount of rain by multiplying the bucket tip count with the amount of rain it took to tip the bucket.

- Once the computer receives the data from ADC in a weather station, it stores the data in the form of a table, which could be done using a spreadsheet or database package so that it can be processed.
- The processing might consist of calculating, for each day, the highest, lowest and mean temperature, the level of UV radiation, total rainfall, hours of sunshine, highest and lowest value of atmospheric pressure and wind speed and direction.
- These values can also be calculated for the month and year to date. Results can be output in the form of graphs, either to a monitor or printed out.
- This all happens automatically without the need for human intervention.

Monitoring Water Pollution

- There are two ways of carrying out water pollution studies
- One is to compare the readings with those that would normally be expected. This requires the lowering of one set of sensors into the river or lake

- The other involves inserting two sets of sensors, one upstream from the suspected site of pollution and the other downstream, immediately after site (such as farm or factory)
- The readings from the two sets of sensors are compared to see if there are any differences of that a conclusion can be reached as to whether the site is causing pollution.
- The sensors feed data to an ADC and then the computer processes the data
- The sensors involved are temperature sensors, pH sensors, turbidity sensors, o2 and CO2 sensors.
- The processing carried out is a comparison of the readings with normal values if it's the first method or comparison of the readings from the two sets of sensors if the second method is being used

Environmental Monitoring

- It is the collection of data relating to our environment. This could be:
- Monitoring sound in cities, in addition to other pollution produced by motor vehicles
- Monitoring soil quality in outdoor gardens and also in greenhouses, using pH sensors, moisture and temperature sensors
- Environmental monitoring can also be linked to climate study and can include
- Detecting abnormally high temperatures using temperature sensors, so that people can be warned of the dangers
- Monitoring the level of air pollution using O2 sensors and CO2 sensors, pH sensors can also help in this regard as they can provide acidity readings
- Monitoring ultraviolet levels, excessive amounts can cause skin cancer so these are often measured by government in high risk countries to judge whether people should be advised to wear skin protection cream.

Calibration

- Calibration is making sure that when for example, temperature sensor is used to measure the temperature of boiling water; it actually causes the computer to output a value of 100 C.
- It is done by comparing the value a sensor produces to a known measurement

The Importance of Calibration

- The accuracy of all sensors reduces after a period of time due to constant use and exposure to the atmosphere or liquids that are being used
- Slight erosion of the sensors material can also cause problems in giving accurate readings
- Regular calibration helps to maintain the accuracy of the sensors
- Other devices within a monitoring system such as ADC may deteriorate over time resulting in a need for recalibration

Methods Used to Calibrate Devices:

- In order to calibrate a temperature sensor, a known temperature value is required
- His could be obtained using heat source such as boiling water for an accurate temperature or using a mixture of ice and water which can give an accurate reading for 0 C
- The sensor generates a voltage which is converted into a temperature reading
- The algorithm to do this can be refined so that the temperature reading matches the actual temperature
- The alternative is to take a reading from a sensor that has already been calibrated and use it to compare the temperature reading of the sensor that is being calibrated

One-Point Calibration

- this type is the easiest to perform
- only one measurement point is needed
- this makes it a particularly appropriate method to use with sensors which have to measure a set temperature or temperature range that is constant
- this type of calibration is often needed for sensors which are constantly used at very high temperatures and after some time loses accuracy, which can be checked by doing one point calibration every so often and comparing the result with the previous calibration
- in order to carry out one point calibration, a reading is taken from the sensor in the range being measured and compared with either a pre-calibrated sensor or known value
- the sensor reading is subtracted from the known which gives an offset value
- this offset is added to every reading in the temperature range being measured

Two-Point Calibration

- It is used with sensors that measure a constantly changing variable
- Two readings need to be taken using the sensor, as it will enable the relationship between the sensor and the standard sensor (pre calibrated) to be established
- It can correct slope and offset errors
- It is best used when readings are linear
- Reading are taken at the low end of the range and the high end of the range
- Readings are taken by a check/reference instrument/ uses previously known readings
- Value for offset is calculated by comparing to known readings

Multi-Point Calibration

- It uses more than two readings from the sensors
- To carry out the calibration, readings are taken at a high value, a middle value and a low known value; for example for temperature sensor, boiling, middle and freezing temperature of water can be take, i.e 100 C, 50 C and 0 C
- This allows a relationship between the sensors and the standardized sensor
- It is best used where readings form a curve or a non-linear relationship
- The calibration cannot be carried out by just adding an offset value or by allowing for the slope
- There is no longer a linear relationship between the two and to calibrate the sensor the algorithm needs to include 'curve fitting'
- It uses a formula to calculate the correction such Uses a quadratic formula such as y =ax2 + bx + c
- Where y is the reading from the standardized sensor and x is the reading from the sensor needing the calibration

Evaluate the use of different forms of calibration

Question	Answer	Marks
6(b)	**SIX** from: **One point calibration Max 2** • Is the easiest method to carry out (1) • Only one point of data is used (1) • Can only be used when measuring set/constant physical variables… (1) – …therefore has a limited use (1) • **Two-point calibration Max 3** • Is more complex **than one point calibration (accept less complex answer)**… (1) – …because is needed when a range of values is being monitored (1) • Two points of data are used (1) • Needs to be used where a linear relationship between sensor readings and the variable being monitored exists… (1) – …therefore, cannot be used when the relationship is a curve (1) • **Multi point calibration Max 3** • Multi-point calibration is the **most** complex method… (1) – used for non-linear, multipoint relationships (1) • Multiple points of data are used (1) • Multi-point calibration is the most complex method… (1) – …greater knowledge of maths is needed (1) **Max. five marks if all three methods not covered** **Max. five marks if bullets/list of points**	**6**

Describe the differences between one point and two point calibrations

6(c)	**Five** from: Only one measurement point/reading with one point calibration whereas with two point calibration at least two readings are taken One point calibration is appropriate for sensors used to measure a value that is constant/never changes… …whereas two-point calibration is used with sensors that measure a constantly changing variable With one point calibration the offset only is calculated/ the sensor reading is subtracted from the known value only… …the offset is then added to every subsequent reading With two point calibration sensitivity needs to be included not just an offset Two point calibration is used where there is a linear relationship between the two readings The slope of the line connecting the two readings is compared with the slope of the line of the pre-calibrated sensor/the range values of the sensor is compared with the range values for the standard Two point calibration compensates for both offset errors and sensitivity/slope errors	**5**

Advantages of computer monitoring	Disadvantages of computer monitoring
Humans are unable to take readings at very frequent intervals as they need to make a note of each reading. This takes time, during which they cannot take another reading. Computers are able to take readings at more frequent intervals and are capable of reading more than one variable simultaneously. Humans can only do one thing at a time, so take longer.	
It is very difficult for humans to keep taking readings for sustained periods, whereas computers can be left on to take readings at any time, day or night. The readings are always taken at regular intervals unlike with a human who might forget to take them.	Computers can be expensive to buy, whereas humans would be expected to do the monitoring as part of their job. Computers are also expensive to maintain.
It takes time for people to draw accurate graphs, whereas computers can produce them automatically after processing the data.	It is quite difficult to program computers to interpret the results, but humans can interpret results and are also needed to program the computers in the first place.
Results are produced automatically after the readings are received by the microprocessor or computer, unlike a human who would take a lot of time to write them down.	
Readings taken by computers tend to be more accurate than those by humans as computers are not subject to 'human error'.	Sensors can deteriorate after a period of time, whereas humans will tend to be more consistent.

This also the answer for evaluate the use of computer in monitoring temp, etc in comparison with traditional methods / humans

3.2 Control technologies

- A control system is the one that uses microprocessors or computers to control certain physical variables such as temperature, pressure, humidity, moisture and light
- Computer can do this by controlling certain devices which can cause the variables to change or maintaining certain physical conditions at the same level for a period of time
- Control system use real time processing.
- They make use of actuators to control devices such as motors
- The output affects the input
- For example, a temperature controlled room, where the temperature is monitored using sensors, if it falls below certain value, the microprocessors sends a signal to heater to switch on which is the output
- The heater being on, heats the room, causing temperature to rise which instantly affects the new input.
- Control system involve continuous processes

Sensors

Type of sensor	Description and use
Electromagnetic field sensor	Often referred to simply as a magnetic field sensor, this sensor measures the change in the Earth's natural magnetic field caused by the presence of a ferromagnetic object. When a vehicle, for example, is above the sensor, the metal in the body of the vehicle distorts the Earth's magnetic field and so its presence is detected. The sensor is small, so its installation and maintenance are easier and cheaper than an induction loop which performs more or less the same function. Magnetic field sensors and induction loops are used at the entrances to car parks to control barriers but magnetic field sensors can be used to detect the number of spaces available. They are also used in some automated car parking systems to help drivers park their car, in a similar way to ultrasonic sensors (see below).
Ultrasonic sensors	An ultrasonic sensor is actually made up of a device that sends out sound waves with a frequency greater than that of the human audible range (so that a human cannot hear it) and a sensor that receives the sound waves which are reflected back. It can be used to measure how far away an object is. It measures the amount of time taken for the sound to be sent and received which, combined with knowledge of the speed of these sound waves, can be used by the microprocessor to calculate the distance. It is used in automated car parking systems which let the driver know when they are close to another vehicle or other object so they can park their car without hitting that obstacle.
Proximity sensor	A proximity sensor can be a mixture of sensors but usually comprises a device that sends out a signal and a sensor which receives the reflected signal back. This can be an infrared beam, ultrasound or a magnetic field. One use is in smartphones to switch off the screen display when the phone is held near to the ear.
Touch sensors	One type of touch sensor is used for measuring fluid levels. A capacitive touch sensor measures the capacitance between two conductors separated by an insulating plate. One of the conductors will be the fluid whose level is being measured. When the fluid is touching the sensor, it detects that it is at that level. This type of sensor is often used in detection devices used to measure fluid levels such as the cooling water level in nuclear power plants to ensure that there is sufficient water to cool the reactors.

Actuators

- An is a device that turns an electrically signal from a microprocessor into a movement
- It is the mechanical part of the control system which provide the output by controlling a device
- such as opening a valve
- It can also be a motor which controls the opening or shutting of windows in a green house

Uses of Control Technology Systems

Greenhouses (glasshouses)

Sensors needed in a greenhouse are:

- A **temperature sensor** to measure the air temperature in the greenhouse
- A **moisture sensor** to measure the water content of the soil
- A **light sensor** to measure the light level inside the greenhouse

Maintaining the required temperature:

- At start of the process, user inputs required temperature (pre-set value) using keypad, number pad or touchscreen
- The computer receives data about the temperature of the greenhouse from the temperature sensor.
- It is passed onto an ADC to convert the analogue to a digital value that computer can understand
- Computer compares sensor data to preset value
- If temperature is above the preset value, it sends a signal to the window motor to open or leave it open if it's already open
- If the temperature is below or equal to preset vale, the computer sends a signal to motor to close the window if its closed or already closed
- It also sends a signal to the actuator to activate the heater or leave it on if it's already on
- The whole process is continuous as long as the system is switched on

```
WHILE system switched on
  INPUT temperature
    IF temperature > preset
      THEN
        IF window closed
          THEN
            send signal to motor to open window
        ENDIF
      ELSE
        IF window open
          THEN
            send signal to motor to close window
        ENDIF
    ENDIF
ENDWHILE
```

```
1  WHILE system switched on
2     INPUT temperature
3        IF temperature > pre-set
4           THEN
5              send signal to window motor to open window or leave it open
6              send signal to actuator to switch off heater or leave it off
7           ELSE
8              send signal to window motor to close window or leave it closed
9              send signal to actuator to switch on heater or leave it on
10       ENDIF
11 ENDWHILE
```

Maintaining the Required Soil Moisture

- At start of process, user inputs required soil moisture level (preset value) using keypad, number pad or touchscreen
- The microprocessor receives data about the amount of moisture in the soil in greenhouse from moisture sensor
- The ADC converts the analogue data into digital value than the computer can understand
- The computer compares the sensor data to the pre-set value input by user
- If moisture level is below preset value, then signal is sent to actuator to activate the sprinkler valve or leave it open if it's already open
- If moisture level is above or equal to preset value then signal is sent to actuator to close sprinkler valve or leave it open it's already open
- Whole process is continuous as long as system is switched on

- Some greenhouse sensors to measure humidity level of air as some plants require high humidity as well as warmth
- These have separate watering systems, one to spray water into air and another to put more moisture into soil

```
1  WHILE system switched on
2     INPUT moisture
3     IF moisture < pre-set
4        THEN
5           send signal to actuator to open sprinkler valve or remain
            open
6        ELSE
7           send signal to actuator to close sprinkler valve or remain
            closed
8     ENDIF
9  ENDWHILE
```

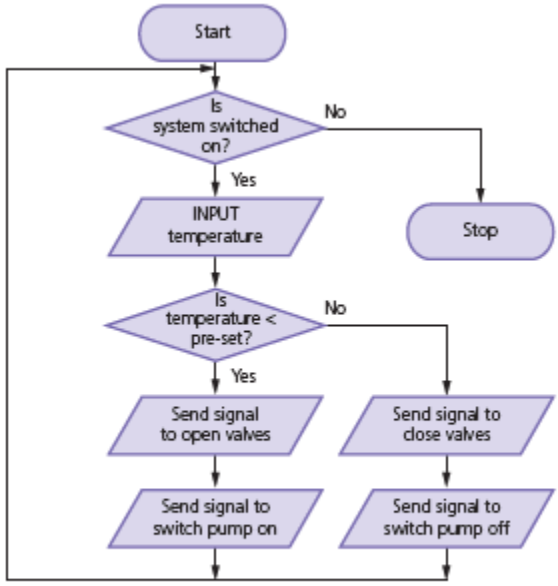
Maintaining the Required Level of Light

- When light is not very good, light source needs to come on so plants have good growing conditions
- A pre-set value still needs to be entered so if light is less than pre-set value, the light source needs to be activated
- However when night comes, the light source needs to be switched off
- A second pre-set value therefore needs to be entered, so that when the amount of light falls below that value, as at night, the light source is switched off
- A light sensor is needed to measure the amount of light coming into the green house and the analogue to digital conversion takes place
- Processing is carried out by the microprocessor
- *Note: pre-set1 is light level below which it is dull during day and pre-set2 is the light level as it gets dark at night time*

```
1  WHILE system switched on
2     INPUT light_level
3     IF light_level < pre-set1
4        THEN
5           IF light_level < pre-set2
6              THEN
7                 send signal to actuator to switch off light source
                  or leave off
8              ELSE
9                 send signal to actuator to switch on light source
                  or leave on
10          ENDIF
11       ELSE
12          send signal to actuator to switch off light source or leave off
13    ENDIF
14 ENDWHILE
```

Central Heating Systems

1. User enters required temperature using keypad/ touchscreen
2. Microprocessor stores required temperature as a pre-set value
3. Microprocessor receives temperature from sensor
4. Microprocessor compares temperature from sensor to pre-set value
5. If temperature from the sensor is lower than the pre-set value, the microprocessor sends a signal to an actuator to open the gas valves
6. If temperature from the sensor is lower than the pre-set value, the microprocessor sends a signal to an actuator to switch the pump on
7. If temperature is higher than or equal to the pre-set value the microprocessor sends a signal to switch the pump off and close the valves
8. This sequence is repeated until the system is switched off



▲ Figure 3.5 Flowchart describing the processing carried out by the microprocessor in a central heating system

Air-Conditioning Systems

1. User enters required temperature using keypad/ touchscreen
2. Microprocessor stores required temperature as a pre-set value
3. Microprocessor receives temperature from sensor
4. Microprocessor compares temperature from sensor to pre-set value
5. If temperature from the sensor is higher than the pre-set value, the microprocessor sends a signal to an actuator to switch on the fans
6. If temperature is lower than, or equal to, the pre-set value, the microprocessor sends a signal to switch the fans off
7. This sequence is repeated until the system is switched off

Burglar Alarms

Microprocessor controlled burglar alarm systems are used in many houses to protect against intruders. The sensors in such a system are:

- **Infra-red sensors** to detect the movement of human bodies, which emit heat
- **Sound sensors** to detect the level of sound an intruder might make
- **Pressure sensors** that are placed under a carpet or rug to detect an increase in weight caused by a burglar treading on it

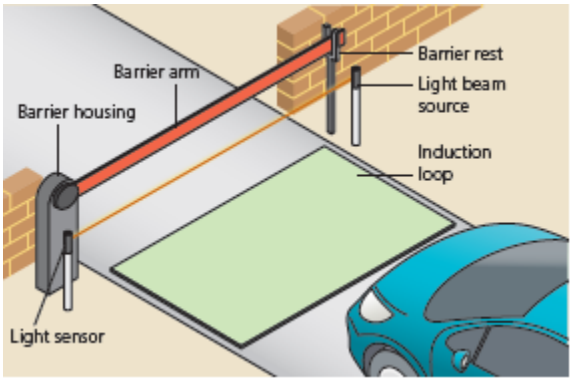
The microprocessor is programmed to have certain acceptable levels ad it only acts if the sensor readings are greater than these. An ADC is required so data from sensor can be understood by the microprocessor. In the event of detecting an intruder, the burglar alarm sounds an alarm and causes light to flash and probably also sends a signal to the police to alert them to the presence of a possible intruder. The system has to be switched on by user for this process to work.

Control of Traffic/Pedestrian Flow

- Smart motorway is a section of motorway that uses active traffic management (ATM) techniques
- The system involves the use of variables speed limits and/or being able to drive on the hard shoulder at certain times

- Computers constantly monitor the road and can change the speed limit or open the hard shoulder to traffic
- Normally traffic isn't allowed o the hard shoulder and a red cross is displayed above it
- If traffic becomes congested, the computer opens up the hard shoulder by moving the red cross
- Computer uses 'side fire radar' which involves the firing of a radar beam at an angle to the roadside
- The device measures the speed of the vehicles it is pointed at by detecting a change in frequency of the radar signal when it is reflected back off an oncoming vehicle
- All this data is constantly fed back to computers which then processes the data and decide what action to take, if the road becomes busy, the system can automatically lower the speed limit or open the hard should to traffic
- The decision made by the computer will often remain free of human intervention unless the decision appears to be unusual

Car Park Barriers



- An induction loop is buried below the surface of the road in front of the barrier.
- As car passes over the loop, it causes a change in induction which is detected by the loop, the metal in the vehicle causes a change in the magnetic field which causes current to flow
- The loop sends back data which is converted to digital and if the computer detects any change compared to a preset value, it sends a signal to the actuator, the motor switch
- Which when activated, it causes the barrier to rise
- A light sensor is used to detect when the vehicle has passed beyond the barrier
- A light beam passes across the space occupied by the vehicle
- If the vehicle prevents the light beam from reaching the sensor, then the microprocessor will keep the barrier raised

- When the vehicle is clear of the barrier, the microprocessor detects the light beam has resumed and sends a signal to the motor to retract and lower the barrier
- This ensures the barrier stays up until the vehicle has passed through the beam
- Ultra sonic sensors are sometimes used in place of light sensors

Ticket issuing car park barrier system:

- Some car park barriers issue a ticket on entry which contains a barcode
- When driver wants to leave car park, they enter the ticket into a machine with barcode reader and then pay for the time parked
- The barcode reader feeds the information to computer and registers that the barcode belongs to a driver that has paid
- As the vehicle leaves the car park, the driver insert the ticket into machine again at barrier which contains another barcode reader
- The computer checks if the barcode matches the list of those barcodes that belong drivers that have paid and sends a signal to the motor to lift the barrier
- Some systems use magnetic strip instead of barcode, while other use automatic number plate recognition
- The customer types in detail of the cars number plate at the ticket machine before paying, when car reaches exit, a camera sends the details of the number plate to computer which uses OCR to read the number plate
- If number plate matches with paid records, then signal is sent to motor to lift the barrier

Traffic Lights

- Computer is programmed to react to different volumes of traffic during the day and uses induction loop to detect these
- The computer receives data from the induction loops by way of ADC and counts the number of vehicles travelling in each direction
- The count is compared with pre-set values and computer changes the traffic timings/sequences as required by sending signals back to control box in the traffic lights, which then operates the new sequences or timings
- The whole process is continuous
- These systems sometimes need to allow for pedestrians crossing at the junction
- The pedestrian presses a button at the side of the road

- The computer registers this input and after a predefined delay sends signal to the actuator to change the traffic lights from green to red
- It also lights up a sign telling pedestrians they can cross
- There can be reasonable delay if the lights have only changed recently but most modern systems using induction lops can tell if traffic is light and thereby reduce time delay

Wireless Sensors and Actuator Networks

- A wireless sensor and actuator network (WSAN) is a network group of sensors and actuators that communicate wirelessly
- They are called WSAN because the actuator might be grouped together to perform a collaborative action and are thus referred to as an actor
- An actor works as if it has a microprocessor included within it because it is capable of making decision
- Example; robot can be an actor, because it contains several actuators in one unit
- Example; smart parking systems, which alerts drivers to where there are car parking spaces available and combined heating, ventilation and air conditioning systems
- Wireless sensors networks are slightly different as they take no action but merely monitor the environment such as wearable computer devices used to monitor an athlete's performance

Smart Homes

- A smart home is a home in which devices and appliances are connected so that anyone can communicate with each other and can be controlled using commands by anyone living in that house
- A smart home makes use of the home computer network and router and is an example of a WSAN
- The commands can be given by voice, remote control, tablet or smartphone
- The most common devices controlled in this way are televisions, music centers, lights, burglar alarms, central heating and air conditioning units
- Smart homes have developed due to the increase in use of smartphones and tablet computers
- These are continuously connected to the internet and can thus be used to control any online devices

- The ability to control such devices through digital network is called Internet of Things (IoT)
- One benefit of smart homes is preventing possible panic occurring when a home owner is on their way to work, i.e forgetting to turn off heating
- However smart homes are vulnerable to hackers, who could access a home network and turn off the burglar system or just cause nuisance such as turning lights off.

Advantages of Using Control Technology

- Microprocessor controlled burglar alarms can give people a greater sense of security as they feel free from the risk of being burgled
- Smart homes can reduce the amount of energy needed to heat and provide light within a home
- The use of computer controlled traffic lights has led to there being fewer traffic jams than when they are mechanically or time controlled
- Air conditioning units in shopping malls tend to make shopping a more comfortable experience when the weather is warm
- Control systems can help people with disabilities who may find difficulty moving around to use devices in their home
- Use of smart home technology can lead to savings in household costs such as electricity as it tends to ensure more economic use of power, switching appliances automatically when not required
- Computer controlled systems process data more quickly than a human could which in turn leads to almost immediate reactions to changes in the inputs to the system
- The use of such systems leave people free to do other things such as pursuing leisure activities since they don't have to be in the houses to do the cooking or washing clothes or dishes
- With computer controlled green houses, a human might forget to take readings, or be busy for it whereas a computer can take readings at regular intervals immediately without delay and at a faster speed.
- Computers can monitor more than one variable at a time whereas a human would have to spend more time taking the readings since they would have to them one at a time
- Readings taken by computers are more reliable and accurate than human readings as humans can make mistakes
- Control commands can be scheduled at any time such day or night without having physical presence of a human

Disadvantages of Using Control Technology

- The use of control technology in such as computer controlled car park barriers has increased unemployment, it has developed new employments such as technicians for maintaining the system but the number of new jobs is far fewer than old jobs that are lost
- Smart homes can lead to people becoming lazy since they become over reliant on microprocessor controlled devices
- Smart homes have caused a loss of manual household skills and prevent people from performing simple exercise such as walking around or using their hands and arms as much as they used to do
- Air conditioning units can lead to increased costs for shops which in turn leads to an increase in prices for the consumer
- Control systems cost a lot of money in first place, i.e smart devices as more expensive than non-smart devices
- A computer controlled system will not be able to function if there is a problem with the computer or there is a power outage without backup power supplies